AGENDA ITEM K-2

CITY OF LODI
COUNCIL COMMUNICATION

AGENDA TITLE: Authorization to Solicit Bids for Artificial Turf Design Services

MEETING DATE: August 5, 2009

PREPARED BY: Interim Parks and Recreation Director

RECOMMENDED ACTION: Authorization to solicit bids for artificial turf design services.

BACKGROUND INFORMATION: Staff is requesting authorization to seek proposals for engineering and design services for the conversion of the existing grass athletic field at the Grape Bowl to synthetic turf.

Services will include studying current conditions, presenting options and recommendations, preparing drawings and bid specifications, providing cost estimates and participating in the bid process and construction administration of the construction contract upon bid award.

City Council gave approval for this project on April 15, 2009. Approval included the leveraging of $150,000 from the sale of the Lockeford property for matching County funding and the use of $1.2 million from the Park Impact Mitigation Fee to install an artificial turf field at the Grape Bowl. The City recently awarded a contract for $300,000 for handicap access, and a local fund-raising effort has resulted in $110,000 in contributions to commence with the Grape Bowl renovations.

Installing artificial turf at the Grape Bowl will greatly increase the availability of practice field space to the community. Most of the City's large athletic fields are also used as storm drainage basins, limiting their use during periods of wet weather. Installing artificial turf at the Grape Bowl will allow the facility to be used year-round, even during periods of wet weather.

Artificial turf is commonplace in public facilities. It is used on community fields in Roseville and Davis, at Manteca's Big League Dreams Sports Complex, at St. Mary's, Lincoln (Stockton), Calaveras and Sonora high schools and San Joaquin Delta College, among many other locations. Artificial turf costs less to maintain, eliminates the need for pesticides and fertilizers and allows for a 70 percent reduction in annual water use.

The Synthetic Turf Council estimates there are 3,500 full-size artificial turf athletic fields, and many other smaller applications such as playgrounds – including one recently installed at the White House. Although there has been discussion about potential health risks associated with lead in older artificial turf fields, health and environmental agencies have recently concluded artificial turf is safe.

The U.S. Consumer Product Safety Commission issued a press release July 30, 2008 (Release #08-348) titled, "CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On," and the New York State Department of Environmental Conservation on May 29, 2009 issued a press release titled, "Study Finds Crumb Rubber Poses No Significant Threat to Air/Water Quality: Tests Show No Health Concerns at Synthetic Turf Fields."

APPROVED: _____
Blair King, City Manager

In 2007, the California Office of Environmental Health Hazard Assessment released a 147-page report on the health effects from using recycled tires on playground surface and concluded risks are minimal (Evaluation of Health Effects of Recycled Waste tires in Playground and Track Products, January 2007).

FISCAL IMPACT: The range of cost for design service is $25,000 to $35,000. Installing an artificial turf field at the Grape Bowl with its existing amenities is less expensive than constructing a new artificial turf field at another location and adding the same amenities as the Grape Bowl. Several conventional grass fields would need to **be** constructed to equal the same recreational capacity as one artificial turf field.

FUNDING: N/A

James M. Rodems
Interim Parks and Recreation Director

cc: City Attorney
Parks Project Coordinator
Parks Superintendent
Purchasing Officer

Application of Synthetic Turf

Grape Bowl Retrofit 2009/10

Lodi City Council
August 5, 2009

Project

- Installation of synthetic turf field in conjunction with ADA renovations scheduled to begin Monday
- Approved 4-0 by City Council on April 15
- Subsequent request for additional information regarding health/safety issues

Alleged health issues

- Hazardous chemicals
- Heat
- Bacteria
- Injuries

Hazardous chemicals

- No levels measured higher than background
- Cancer risk claims unsubstantiated
- Non-toxic byproducts do not degrade into hazardous materials
- Runoff not hazardous to aquatic life, environment

Heat

- No “heat island” effect
- Surface temperature hotter than grass turf
- Temperature increase can be up to 40 degrees above ambient temperature
- Watering can cool field to within 15 degrees of ambient temperature

Bacteria

- Staphylococcus has not been found in infill synthetic turf fields
- Materials used inhibit bacterial growth
- Field temperatures may kill bacteria

Injuries

- Higher in some instances for turf, higher in others for grass fields
- Conclusions: Artificial turf no more harmful than natural surface
  - Meyers and Barnhill, 2004, American Journal of Sports Medicine, study of Texas High School football players
  - Fuller, et al, 2007, British Journal of Sports Medicine, analysis of NCAA data
  - Ekstrand, et al, 2006, British Journal of Sports Medicine, analysis of injury data from 10 European professional soccer teams

Why synthetic turf?

- All-weather field usable year-round, increasing use by a factor of 10
- 88% decrease in maintenance costs
- 70% decrease in water use
- Reduced replacement costs
  - By 63% compared to annual resodding
  - By 20% compared to resodding every three years

Year-round use

- Natural turf limited to 76 events/year
- Minimum number of events/year: 769
- Maintenance cost/event:
  - Turf = $924.43
  - Synthetic = $66.32
- Recapture five months of field access.

Maintenance costs

78,000 square-foot field:

Natural turf annual costs	$60,000
Synthetic turf annual costs	$ 4,500
Reduction in water use	70%
Elimination of chemical insecticides, herbicides and fertilizers	
Prep time for natural turf	2-3 days
Prep time for synthetic turf	2 hours

Replacement

- Synthetic turf costs 17% less to replace than resodding over the same time
- Numbers given in preliminary reports are for 100% replacement
- Estimate replacing only 20-25% of the field at 15-20 years
- Actual cost to be determined as part of project

Conclusion

Artificial turf at the Grape Bowl is a cost-effective, safe way to vastly increase available athletic fields to the community

Artificial turf studies

Environmental effects

1. An Assessment of Chemical Leaching, Releases to Air and Temperature At Crumb-Rubber Infilled Synthetic Turf Fields; 2009, New York Department of Environmental Conservation.

2. Follow-Up Study of the Environmental Aspects of Rubber Infill; 2008, Tyre and Environment Association, Netherlands.

Health and Public Safety

3. Evaluation **of** Health Effects of Recycled Waste Tires in Playground and Track Products; 2007, California Environmental Protection Agency, Office of Environmental Health Hazard Assessement.

4. Fact Sheet -- Crumb-Rubber Infilled Synthetic Turf Athletic Fields; 2008, State of New York Department of Health

5. Fact Sheet -- Artificial Turf Fields: Health Questions; 2007, Connecticut Department of Public Health, Environmental and Occupational Health Assessment Program

6. Potential Exposure to Lead in Artificial Turf: Public Health Issues, Actions, and Recommendations; **2008,** Centers for **Disease** Control and Prevention.

7. A Review of the Potential Health and Safety Risks From Synthetic Turf Fields Containing Crumb Rubber Mill; 2008, New York City Department of Health and Mental Hygiene

8. CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On; 2008, U.S. Consumer Product Safety Commission press release

Risk of Injury

9. Risk of Injury in Elite Football Played On Artificial Turf Versus Natural Grass: A Prospective Two-Cohort Study; 2006, British Journal of Sports Medicine

10. Comparison of the Incidence, Nature and Cause **of** Injuries Sustained On Grass and New Generation Artificial Turf by Male and Female Football Players; 2007, British Journal of Sports Medicine

11. Incidence, Causes, and Severity of High School Football Injuries on FieldTurf Versus Natural Grass; 2004, American Journal of Sports Medicine

12. **Risk** of **Injury** on Artificial Turf and Natural Grass in Young Female Football Players; **2007,** British Journal of **Sports** Medicine

Additional Information

13. How Safe Are The New Artificial Turf Fields? Jay H. Williams, Ph.D., Virginia Tech University

AN ASSESSMENT OF CHEMICAL LEACHING, RELEASES TO AIR AND TEMPERATURE AT CRUMB-RUBBER INFILLED SYNTHETIC TURF FIELDS

New York State Department of Environmental Conservation

New York State Department of Health

May 2009

Executive Summary

This report presents the findings from a New York State Department of Environmental Conservation (NYSDEC) study, designed to assess potential environmental and public health impacts from the use of crumb rubber as infill material in synthetic turf fields. The New York State Department of Health (NYSDOH) evaluated the potential public health risks associated with the air sampling results. The study focused on three areas of concern: the release and potential environmental impacts of chemicals into surface water and groundwater; the release and potential public health impacts of chemicals from the surface of the fields to the air; and elevated surface temperatures and indicators of the potential for heat-related illness ("heat stress") at synthetic turf fields.

The study included a laboratory evaluation, applied to four types of tire-derived crumb rubber (car, truck, a mixture of car and truck, and a mixture cryogenically produced), to assess the release of chemicals using the simulated precipitation leaching procedure (SPLP). The results of this evaluation indicate a potential for release of zinc, aniline, phenol, and benzothiazole. Zinc (solely from truck tires), aniline, and phenol have the potential to be released above groundwater standards or guidance values. No standard or guidance value exists for benzothiazole. However, as leachate moves through soil to the groundwater table, contaminant concentrations are attenuated by adsorption and degradation, and further reduced by dilution when contaminants are mixed with groundwater. An analysis of attenuation and dilution mechanisms and the associated reduction factors indicates that crumb rubber may be used as an infill without significant impact on groundwater quality, assuming the limitations of mechanisms, such as separation distance to groundwater table, are addressed.

Analysis of crumb rubber samples digested in acid revealed that the lead concentration in the crumb rubber samples were well below the federal hazard standard for lead in soil and indicate that the crumb rubber from which the samples were obtained would not be a significant source of lead exposure if used as infill material in synthetic

turf fields. The evaluation of volatile and semi-volatile organic compounds by off-gassing proved difficult to conduct quantitatively due to the strong absorptive nature of the crumb rubber samples but the results did provide useful information for additional analytes in the ambient air field investigation.

A risk assessment for aquatic life protection performed using the laboratory SPLP results, found that crumb rubber derived entirely from truck tires may have an impact on aquatic life due to the release of zinc. For the three other types of crumb rubber, aquatic toxicity was found to be unlikely. When the results of the column tests are used in this risk assessment model, no adverse impacts are predicted for any of the crumb rubber types evaluated. Although the SPLP results predict a greater release of chemicals, the column test is considered more representative of the field conditions.

The study also included a field sampling component for potential surface and groundwater impacts. This work has not been fully completed at the time of this report. The groundwater sampling that was conducted shows no impact on groundwater quality due to crumb rubber related compounds, but this finding should not be considered as conclusive due to the limited amount of data available. Additional sampling of surface and groundwater at crumb-rubber infill synthetic turf fields will be conducted by NYSDEC. The results will be summarized in a separate report.

A field evaluation of chemical releases from synthetic turf surfaces was conducted at two locations using an air sampling method that allowed for identification of low concentration analytes and involved the evaluation of the potential releases of analytes not previously reported. Few detected analytes were found. Many of the analytes detected (e.g., benzene, 1,2,4-trimethylbenzene, ethyl benzene, carbon tetrachloride) are commonly found in an urban environment. A number of analytes found in previous studies evaluating crumb rubber were detected at low concentrations (e.g., 4-methyl-2-pentanone, benzothiazole, alkane chains (C4-C11)).

A public health evaluation was conducted on the results from the ambient air sampling and concluded that the measured levels of chemicals in air at the Thomas Jefferson and John Mullaly Fields do not raise a concern for non-cancer or cancer health effects for people who use or visit the fields.

The ambient air particulate matter sampling did not reveal meaningful differences in concentrations measured on the field and those measured upwind of the field. This may be explained by the lack of rubber dust found in the smaller size fraction (respirable range) through the application of aggressive sampling methods on the surface of the fields. Overall, the findings do not indicate that these fields are a significant source of exposure to respirable particulate matter.

The results of the temperature survey show significantly higher surface temperatures for synthetic turf fields as compared to the measurements obtained on nearby grass and sand surfaces. While the temperature survey found little difference for the indicators of heat stress between the synthetic turf, grass, and sand surfaces, on any given day a small difference in the heat stress indicators could result in a different guidance for the different surface types. Although little difference between indicators of heat stress measurements was found, the synthetic turf surface temperatures were much higher and prolonged contact with the hotter surfaces may have the potential to create discomfort, cause thermal injury and contribute to heat-related illnesses. Awareness of the potential for heat illness and how to recognize and prevent heat illness needs to be raised among users and managers of athletic fields, athletic staff, coaches and parents.

This assessment of certain aspects of crumb-rubber infilled synthetic turf fields was designed to collect data under conditions representative of "worst case" conditions (e.g., summer-time temperatures that should maximize off-gassing of chemicals). However, samples collected under different conditions, using different methods or at different fields could yield different results. For example, the results of measurements may be different for fields of other ages or designs (e.g., different volumes of crumb rubber infill, non-crumb rubber infill) or for indoor fields. This report is not intended to

broadly address all synthetic turf issues, including the potential public health implications associated with the presence of lead-based pigments in synthetic turf fibers. Information about lead in synthetic turf fibers is available in a Centers for Disease Control and Prevention Health Advisory available at http://www2a.cdc.gov/han/archivesys/ViewMsgV.asp?AlertNum=00275

FOLLOW-UP STUDY OF THE ENVIRONMENTAL ASPECTS OF RUBBER INFILL

A laboratory study (perform weathering tests) and a field study

rubber crumb from car tyres as infill on artificial turf

Summary

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Datum / Date 31 March 2008

Auteur / Author dr. U. Hofstra

SUMMARY

In **2006** and **2007,** a broad-based study was conducted into the environmental impact and health risks of the use of rubber infill **from** recycled tyres on artificial turf. The study showed that there was no threat of any significant environmental impact or health **risks,** with the possible exception **of** the risk to the environment caused by zinc leaching **from** the rubber in the long term. **This** was the reason for a follow-up study, which was intended to answer the question **of** whether zinc leaching from rubber infill poses a risk to the environment in the long term.

The study was carried out by INTRON in Sittard, in association with TNO Quality Services, and was commissioned by the VACO (Tyre and Wheel Trade Association) and the Vereniging Band & Milieu (Tyre and the Environment Association) in consultation with the Ministry of Housing, Spatial Planning and the Environment (VROM) and the National Institute for Public Health and the Environment (RIVM).

The study
The study was divided into two phases: a laboratory study and a field study.

In the laboratory, a lysimeter set-up in a climate chamber was used to perform weathering tests on artificial turf systems with rubber infill from car tyres. The weathering process of the rubber was accelerated in order to measure the effect of weathering on the leaching of zinc. Both shredded car tyres and shredded commercial vehicle tyres were tested for the amount of zinc that leached out of the rubber infill.

Both systems without an underlay and with **a** lava underlay (10 cm thick) were tested. The leaching from a system with a sand layer (40 cm thick) was calculated using an absorption coefficient for sand based on information in the literature.

The field study consisted of analysing the drainage water from six artificial turf fields to ascertain exactly how much zinc leaches out of an artificial turf field with rubber infill made from rubber crumb from car tyres.

Weathering tests
In combination with high temperature, ozone is the main cause of degradation in car tyre rubber. The tests with the lysimeter showed that in a concentration of ozone 15 times higher than the outside atmosphere, the leaching of zinc increases and then remains constant.

The leaching of zinc from artificial turf with rubber infill from commercial vehicle tyres is twice **as** high **as** leaching from artificial turf with rubber infill from car tyres.

The leaching of zinc was measured in the percolation water in the lysimeter and by means of **a** column test of the rubber crumb weathered in the lysimeter. The data from both of these leaching methods was used to calculate the cumulative leaching of the entire artificial turf system, including lava underlays and drainage sand, and extrapolated over a period **of** several decades.

The horizontal dotted line in the graphs is the policy standard for the emission of zinc into the soil, which is derived from the Decree on Soil Quality.

Contractor's Report to the Board

Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products

Produced under contract by: OEHHA
Office of Environmental Health Hazard Assessment

January **2007**

INTEGRATED
WASTE
MANAGEMENT
BOARD

Executive Summary

In response to the California Integrated Waste Management Board's (CIWMB) need to better understand the potential health risks to children using outdoor playground and track surfaces constructed from recycled waste tires, the Office of Environmental Health Hazard Assessment (OEHHA) conducted the following studies.

- The playground surfaces were evaluated for the release of chemicals that could cause toxicity in children following ingestion or dermal contact. Three routes of child exposure to chemicals in the rubber were considered: 1) ingestion of loose rubber tire shreds (acute exposure), 2) ingestion via hand-to-surface contact followed by hand-to-mouth contact (chronic exposure), and 3) skin sensitization via dermal contact (acute exposure).
- Playground surfaces constructed from recycled tires were tested for their ability to attenuate fall-related impacts.
- The potential of these rubberized surfaces to impact the local environment, including the local ecology, was also addressed through a discussion of the published literature.

Evaluation of toxicity due to ingestion of tire shreds based on the existing literature

OEHHA found 46 studies in the scientific literature that measured the release of chemicals by recycled tires in laboratory settings and in field studies where recycled tires were used in civil engineering applications: **49** chemicals were identified. Using the highest published levels of chemicals released by recycled tires, the likelihood for noncancer health effects was calculated for a one-time ingestion of ten grams of tire shreds by a typical three-year-old child; only exposure to zinc exceeded its health-based screening value (i.e., value promulgated by a regulatory agency such as OEHHA or U.S. EPA). Overall, we consider it unlikely that a one-time ingestion of tire shreds would produce adverse health effects. Seven of the chemicals leaching from tire shreds in published studies were carcinogens, yielding a 1.2×10^{-7} (1.2 in ten million) increased cancer risk for the one-time ingestion described above. This risk is well below the ***di minimis*** level of 1×10^{-6} (one in one million), generally considered an acceptable cancer risk due to its small magnitude compared to the overall cancer rate (OEHHA, 2006).

Evaluation of toxicity due to ingestion of tire shreds based on gastric digestion simulation

OEHHA conducted a gastric digestion experiment in which **22** chemicals were found to be released by tire shreds incubated for 21 hours at 37°C in a solution mimicking the gastric environment. OEHHA then compared the levels of released chemicals to their health-based screening values, assuming a young child ingested ten grams of tire shreds; all exposures were at or below the screening values suggesting a low risk of noncancer acute health effects. Five of the chemicals released by tire shreds in the gastric digestion experiment were carcinogens. If the released chemicals were ingested as a onetime event and averaged over a lifetime, the cancer risk would be 3.7×10^{-8} (3.7 in one hundred million). This risk is considerably below the ***di minimis*** risk level of 1×10^{-6} (one in one million), generally considered an acceptable cancer risk due to its small magnitude compared to the overall cancer rate (OEHHA, 2006). The assumption that the risk from a onetime exposure is equivalent to the risk from the same dose spread over a lifetime is uncertain, and may overestimate or underestimate the true risk.

Evaluation of toxicity due to chronic hand-to-surface-to-mouth activity

OEHHA performed wipe sampling of in-use playground surfaces containing recycled tire rubber; one metal (zinc) and four PAHs were measured at levels that were at least three times background. Assuming ingestion of the above five chemicals via chronic hand-to-mouth contact, exposures were below the corresponding chronic screening values, suggesting a low risk of

adverse noncancer health effects. From among the five chemicals identified by wipe sampling, the PAH chrysene is a carcinogen. Assuming playground use from 1 through 12 years of age, an increased cancer risk of 2.9 x 10^{-6} (2.9 in one million) was calculated due to the chronic ingestion of chrysene. This risk is slightly higher than the *di minimis* risk level of 1 x 10^{-6} (one in one million), generally considered an acceptable cancer risk due to its small magnitude compared to the overall cancer rate (OEHHA, 2006). Calculation of the 2.9 x 10^{-6} (2.9 in one million) value does not account for many uncertainties, some of which would decrease the risk while others would increase the risk.

Testing for skin sensitization by playground surfaces made of recycled tires

Since children commonly contact these rubberized surfaces with their hands and other body parts, and since natural rubber contains the proven skin sensitizer latex, OEHHA contracted a laboratory to perform skin sensitization testing of tire-derived surfacing. Skin sensitization testing in the guinea pig was performed by Product Safety Laboratories (Dayton, NJ) with tire-derived playground surfacing as well as with the synthetic rubber EPDM, no sensitization was observed, suggesting that these surfaces would not cause skin sensitization in children, nor would they be expected to elicit skin reactions in children already sensitized to latex.

Evaluating the potential for damage to the local environment and ecology

Following a fire in a playground surface made of chipped tires at the Yulupa Elementary School in Sonoma County, soil samples from under the playground contained levels of metals, VOCs, PAHs, dioxins and furans that were at or below background, suggesting a low risk to the local ecology. Also following the Yulupa fire, the air above the burn site was judged by U.S. EPA to pose no health risks to clean-up workers, and the soil/rubber mixture removed from the site was judged not to be hazardous waste, and could therefore be deposited in a designated class III waste facility.

Groundwater in contact with tire shreds contained elevated levels of many chemicals; however, those levels rapidly approached background a few feet outside of the tire trench. Additional published studies indicate that concentrated leachate produced in the laboratory from tire shreds, crumb rubber or whole tires was toxic in 19/31 studies to a variety of organisms including bacteria, algae, aquatic invertebrates, fish, frogs and plants; however, it is unlikely that the use of shredded tires in outdoor applications such as playground surfaces would result in the leaching during rain events of high enough concentrations of chemicals to cause such effects. Further, shredded tires used in applications above the ground water table, as is the case for playground surfaces, produced no toxicity in sentinel species.

Evaluation of potential injury from falls on playground surfaces made of recycled tires

Using an accelerometer to test impact attenuation by California playground surfaces made of recycled tires, OEHHA staff visited 32 rubberized playground surfaces, to determine if the state mandated (CCR sections 65700-65750) standard for head impact (Head Impact Criterion or HIC) of $\leq$ 1000 was being met. Only 31 percent of rubberized playground surfaces passed the HIC standard. This is compared to 100 percent for surfaces made of wood chips, although only five surfaces of wood chips were tested. As the fall heights of playground structures increased, the underlying rubberized playground surface was more likely to fail the HIC standard; however, even at fall heights of 9-12 feet, some rubberized surfaces passed the standard. HIC values were not affected by the age of the rubberized surface, either during the first 2-3 months following installation or during the first two years. HIC values of rubberized surfaces increased with increasing surface temperature; in one playground the HIC value measured at dawn increased almost 20 percent when measured again in the afternoon during the heat of the day. These data point out the importance of testing the impact attenuation of rubberized playground surfaces to ensure that they meet the safety standards already in place.

STATE OF NEW YORK
DEPARTMENT OF HEALTH
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Richard F. Daines, M.D.
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FACT SHEET
Crumb-Rubber Infilled Synthetic Turf Athletic Fields
August 2008

PURPOSE
There are several kinds of synthetic turf surfaces (*e.g.*, surfaces that use a fill material ("infill") between the blades of artificial grass and those that do not), and synthetic turf may be installed for different uses (*e.g.*, single or multiple sport athletic fields, landscaping, golf applications). The focus of this fact sheet is athletic fields with crumb rubber infilled synthetic turf. This fact sheet was developed to assist people in making decisions about installing or using this kind of synthetic turf athletic field. Considerations related to other kinds of synthetic turf fields are not addressed in this fact sheet.

BACKGROUND
The first well-publicized use of AstroTurf, a synthetic turf for athletic fields, was at the Houston Astrodome in 1966. This first generation of synthetic turf was essentially a short pile carpet with a foam backing. Since then, design changes have resulted in a greater variety of synthetic turf athletic fields. One type of synthetic turf is fabricated using synthetic fibers, manufactured to resemble natural grass, and a base material that stabilizes and cushions the playing surface. The fibers are typically made from nylon, polypropylene or polyethylene and are connected to a backing material. The base material, also called infill, consists of one or more granular materials that are worked in between the fibers during the installation process. Commonly used base materials are granulated crumb rubber (usually from used tires), flexible plastic pellets, sand, and rubber-coated sand. A combination of sand and crumb rubber is often used.

Crumb rubber is produced by grinding used tires. Steel and fiber tire components are removed during the process and the rubber pellets are sorted by size. Pellet sizes ranging from about one-sixteenth to one-quarter inch in diameter are used on synthetic turf. Crumb rubber is typicdlly applied at a rate of two to three pounds per square foot of field surface.

HEALTH AND SAFETY CONSIDERATIONS
Some potential health and safety considerations related to synthetic turf have generated public concern. These include:

- Heat stress
- Injury
- Infection
- Latex allergy
- Chemical exposure

Heat Stress

Synthetic turf fields absorb heat, resulting in surface temperatures that are much higher than the temperatures of the surrounding air. In June 2002 at Brigham Young University (BYU) in Utah, the average surface temperature on a synthetic turf field was reported to be 117°F while the average surface temperatures on natural turf and asphalt were 78°F and 110°F, respectively. A maximum surface temperature of 200°F on the BYU synthetic turf field was reported. A turfgrass specialist at the University of Missouri reported measuring an air temperature of 138°F at "head-level" height on the university's synthetic turf field on a sunny 98°F day. The surface temperature of the field was reported to be 178°F. A study conducted at Penn State University measured surface temperatures on experimental plots of nine different types of infilled turf. Temperature measurements were made on three occasions. The average air temperatures reported were 79°, 78°, and 85°F. The corresponding average surface temperatures reported for the synthetic turf plots are 120°, 130" and 146°F.

Water can be applied to synthetic turf to reduce the surface temperatures on warm days. A study at BYU found that watering synthetic turf lowered the surface temperature from 174°F to 85°F, but the temperature rose to 120°F in five minutes and to 164°F in twenty minutes. A study conducted by Penn State University on experimental synthetic turf plots examined the effect of watering synthetic turf on surface temperature. Measurements were made on three occasions. For one monitoring period, surface temperatures ranging from about 130" to 160°F were lowered initially to about 75°F, but increased within 30 minutes to temperatures ranging from about 90° to 120°F, where they remained fairly stable for the three-hour monitoring period.

The surface temperatures reported on synthetic turf fields can get high enough to reach levels of discomfort and may contribute to heat stress among users of the fields. While watering synthetic turf may reduce surface temperatures, other factors are likely to influence its effectiveness. At the present time, NYSDOH is unaware of any studies that have examined the role of synthetic turf in contributing to heat stress or that have compared the occurrence of heat stress among athletes playing on natural turf and synthetic turf.

Because of the potential for high temperatures on infilled synthetic turf fields, it is important that people who play or work on the fields be provided with adequate warnings regarding the potential for heat stress. People should also be advised to remain hydrated and to seek relief from the heat in shaded areas. The potential for and frequency of high surface temperatures warrant consideration when making decisions about installing and using a synthetic turf field.

Injury

There is a common perception that there are more sports injuries on synthetic than on natural turf athletic fields. Many factors influence the rate of sports injuries, including the type of playing surface. The many kinds of synthetic turf surfaces and changes in the turf products over the years complicate the assessment of how the playing surface affects injury rates. Other risk factors have been implicated in injury rates among athletes, in addition to the type of playing surface. These risk factors include level of competition, skill level, age, shoe type, previous injury and rehabilitation, and a number of individual physical characteristics. We identified five studies that compared injury (*e.g.,* sprains, lacerations, fractures) rates among athletes when playing on infilled synthetic turf and natural turf fields. Although the ability of the studies to detect differences in the injury rates was limited by the small number of injuries reported, the

studies concluded that there were no major differences in overall injury rates between natural and infilled synthetic turf. Although each study found some differences in specific injury types, there was no consistent pattern across the studies.

The potential for head injuries from contact with the surfaces has been assessed by determining the ability of the surfaces to absorb impacts. Tests have shown that the force of impact on asphalt surfaces is much higher than the level generally accepted to be associated with serious head injury. The force of impact on many types of natural turf and all types of synthetic turf tested are below this level. The force of impact on frozen natural turf is typically above the acceptable level. No data are available for the force of impact on frozen synthetic turf.

The abrasiveness of synthetic turf fibers may contribute to the injury risk among athletes, particularly for abrasions or "turf burns." The degree of abrasiveness appears to be dependent on the composition and shape of the turf fibers. A study conducted at Penn State University suggests that synthetic turf with nylon fibers is more abrasive than synthetic turf with other types of fibers.

Infection Risk

Some people have expressed concern that infections, including methicillin-resistant ***Staphylococcus aureus*** (MRSA), may be more common among users of synthetic turf fields than users of natural turf fields. This possibility has not been studied systematically, and no definitive statements can be made about differences in **risk** between the two surfaces.

At least two questions are important in evaluating the risk of infection. Does skin damage occur more frequently on synthetic turf than natural turf, thus providing a place where infections are more likely to occur? Are there more germs on synthetic turf than natural turf?

While injury studies have not consistently identified differences in abrasion and laceration risks between natural and infilled synthetic turf, some types of synthetic turf may result in more skin abrasions. Although very few tests have been performed, the available data do not suggest the widespread presence of infectious agents, such as MRSA, on synthetic turf fields. Also, the available information indicates that outdoor or indoor synthetic turf surfaces are no more likely to harbor infectious agents than other surfaces in those same environments. Disease outbreak investigations conducted in response to illnesses caused by a variety of germs (***e.g.*, MRSA, *Campylobacter***, meningococcus, echovirus, herpes simplex virus, hepatitis virus, coxsackie virus) have not identified playing fields, either natural or synthetic, as likely to increase the risk of transmitting infections.

Skin cuts and abrasions that may result from contact with athletic fields, including both natural and synthetic fields, are susceptible to infection. Athletes and others developing **skin** abrasions should clean the wounds and seek prompt medical attention. Athletes should avoid sharing towels (on and off the field), equipment, razors, soap and other objects with others, because sharing these items can spread germs.

Latex Allergy

Latex, a substance found in natural rubber, contains substances called "latex allergens," which can cause an allergic response in some people. About **6** percent of the general population is allergic to the substances in latex. Tire rubber contains the latex allergen, although at much lower levels than in latex

gloves and other consumer products. People playing on synthetic turf may be exposed to latex allergens through direct contact with the skin (dermal exposure) and inhalation of small rubber particles suspended in the air.

A study conducted for the California Environmental Protection Agency tested samples of tire rubber on the skin of guinea pigs. None of the animals developed any rashes or allergic reactions from contact with the rubber.

Whether crumb rubber can cause an allergic response in people is not known. NYSDOH is unaware of any occurrences of latex allergy associated with contact with crumb rubber or synthetic turf fields.

Chemical Exposure

Exposure to a chemical requires contact with it. Contact with a chemical occurs in three ways: swallowing it (ingestion exposure), breathing it (inhalation exposure), and having it come in contact with the skin (dermal exposure) or eyes (ocular exposure). The potential for harmful effects from exposure to a chemical depends on the amount of the chemical a person contacts, how the chemical enters the body (ingestion, inhalation, dermal, or ocular), how often contact occurs, and the toxic properties of the chemical. The ability of a chemical to be released from a substance (*e.g.,* crumb rubber) is an important factor in determining how much exposure actually occurs. Other factors that can influence a person's risk for adverse health effects from environmental chemicals include age, gender, general health, genetic differences, exposure to other chemicals and lifestyle choices.

Tires are manufactured from natural and synthetic rubbers along with numerous chemical additives, including zinc, sulfur, carbon black, and oils that contain polyaromatic hydrocarbons (PAHs) and volatile organic chemicals. Because crumb rubber is manufactured from used tires, it probably contains the same chemicals as tire rubber.

Studies have been conducted by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment and the Norwegian Institute of Public Health to assess the potential for ingestion exposure to the chemicals in crumb rubber by children playing on synthetic turf. Both studies concluded that health risks to children resulting from the ingestion of crumb rubber are low.

The Norwegian Institute of Public Health also collected data to assess potential health risks resulting from dermal and inhalation exposures to chemicals contained in synthetic turf fields. Health assessments were conducted for adults and children. The researchers concluded that adverse health effects resulting dermal exposures to crumb rubber or from inhalation exposures to organic chemicals released from the fields are unlikely. No health assessment of the concentrations of rubber particles in the air was made.

A French study measured the concentrations of organic chemicals emitted as gases (known as volatile organic compounds or VOCs) from crumb rubber under laboratory conditions. The data were used by the French National Institute for Industrial Environment and Risks to evaluate possible health effects from inhaling VOCs released from synthetic turf. The study authors concluded that the concentrations of organic compounds emitted did not pose a health concern for athletes, officials or spectators.

Some types of synthetic turf fibers contain elevated levels of lead (*e.g.*, in the range of about 2,000 to 9,000 parts per million). Degradation of these fibers can form a dust that presents a potential source of

lead exposure to users of the fields. The Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry addressed the potential for lead exposures from synthetic turf fibers in a June 2008 Health Advisory (http://www.cdc.gov/nceh/lead/artificialturf.htm). For new or replacement installations, select synthetic turf products that do not have elevated lead levels.

Our review of the available information on crumb rubber and crumb rubber infilled turf fields indicates that ingestion, dermal or inhalation exposures to chemicals in or released from crumb rubber do not pose a significant public health concern.

OTHER CONSIDERATIONS

A number of other factors may need to be considered when installing and using synthetic turf.

Use: Synthetic turf is more durable than natural turf and can be used without the rest periods that natural turf requires to keep the turf healthy. The New York City Department of Parks and Recreation (NYCDPR) estimates that on an annual basis, permitted use (hours per year) for synthetic turf athletic fields is 28 percent higher than for natural grass fields.

Installation: Installation costs **of** synthetic turf vary depending on the amount of site preparation required and the specific field design. The installation costs of synthetic turf are generally much higher than the installation costs of natural turf.

Maintenance: The maintenance costs of synthetic turf will vary depending on the field's use and design, but are typically estimated to be lower than the maintenance costs of natural turf. Natural turf requires regular mowing, fertilizer application, pest control and possibly watering. Synthetic turf requires replacing infill materials, repairing seams and removing weeds and moss. Specialized equipment, which may or may not be included in the field's purchase price, is required for these activities.

Lifetime: NYCDPR estimates that the lifetime of a natural turf field is on the order of five years. The synthetic turf industry estimates that the lifetime of an infilled synthetic turf athletic field is eight to ten years, depending on care during installation and use. NYCDPR and other New York entities have seen similar lifetimes.

FACT SHEET

October 2007

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Artificial Turf Fields: Health Questions

Cities and towns across Connecticut have increasingly opted for replacement of grass fields with a form of artificial turf that uses recycled rubber tires. The tires are processed into crumb rubber and used as an infill material to cushion the playing surface. Stated advantages over natural grass fields are reduced watering and maintenance, avoiding the need for pesticides, reduced injuries, and an "all-weather" playing surface. Questions have been raised regarding health, safety and environmental aspects of the rubber infill material. Rubber contains industrial chemicals that can be released into the air during playing and which may run off into the environment in rainwater. This fact sheet focuses upon the potential health effects to athletes and spectators using these fields, many of whom are school-age children.

What Chemicals Can Be Released By The Infill Material?

Some chemicals in rubber vaporize to form a gas (volatile organic chemicals or VOCs such as toluene and benzothiazole), while others remain in the solid-phase (e.g., metals, polycyclic aromatic hydrocarbons or PAHs). Given the variety and types of chemicals involved, it is not surprising that some have toxic or carcinogenic activity when tested in laboratory animals. **VOC** release from crumb rubber infill is expected to be greatest in sunny, hot weather. Particle release may be affected by the number of athletes using the field and the intensity of their exercise. Temperature gradients and wind will generally afford rapid dilution and low concentrations in the breathing zones of athletes.

How Can People Be Exposed To Rubber Chemicals At Artificial Turf Fields?

Inhalation and ingestion exposures are possible. Because their play may create airborne particles and because of their high ventilation rate, athletes are expected to receive the greatest exposure. Athletes may also inadvertently ingest dust particles that cling to hands and clothing. Those on the sidelines or grandstands will receive lower exposures. It is also possible that if young children accompany parents to these fields, they may swallow the infill material itself, although the ingestion of whole granules is not likely to be a frequent occurrence. This possibility may increase if artificial **turf** fields are placed at elementary schools and playgrounds. Since the particles cling to shoes and clothing, it is possible for the infill material to be tracked into homes after leaving the field. This is expected to cause much less exposure than from the fields themselves.

Are People Exposed To These Chemicals In Other Ways?

Yes. Most of the chemicals emitted from the rubber granules are quite common in urban and suburban air. Some comes from rubber itself as roughly 1-2% of the respirable dust in Los Angeles is estimated to come from the wearing of tires. Other sources for these chemicals are also quite common including car exhaust, furnaces, consumer products, flooring and foods. For example, studies in California demonstrate that rubber-based resilient flooring off-gases benzothiazole and other rubber-related VOCs. These materials are commonly used indoors in schools.

Is There A Health Risk?

Based upon the current evidence, a public health risk appears unlikely. However, there is still uncertainty and additional investigation is warranted A variety of governmental bodies including Norway, Sweden, New Jersey and California have recently reviewed the health issues; their assessments have not found a public health threat. Sources of exposure unrelated to artificial turf fields are likely more important than the turf fields for many chemicals. While DPH does not believe there is a unique or significant health threat from chemical releases that can be inhaled or ingested, the uncertainties warrant further investigation.

Should Towns Continue To Install This Type Of Artificial Turf Field?

DPH's review does not find any reason to stop installation of these fields. Currently there are no federal or state limits on the installation of crumb rubber-based turf fields. Therefore, it is up to towns to make a case-by-case decision on whether artificial turf is the right choice for a particular setting. While we see no health evidence to stop installations, DPH acknowledges that much of the information is very recent and this area is rapidly evolving. Additionally, the potential exposures and risks have not been fully characterized. DPH recommends that towns consider these uncertainties as part of the array of issues evaluated when deciding whether to install artificial turf fields (e.g., cost, maintenance, public acceptability).

Where Can I Get More Information?

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Potential Exposure to Lead in Artificial Turf: Public Health Issues, Actions, and Recommendations

Public Health Issues

In the course of conducting a routine health investigation at a metal facility in Newark, NJ, the New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) tested a nearby community athletic field for lead contamination. Samples taken from the field showed high levels of lead in the field dust, but the lead did not come from the scrap metal facility.

The Centers for Disease Control and Prevention (CDC) is partnering with its sister-agency, ATSDR, to monitor this situation because of CDC's expertise in lead poisoning prevention.

After determining that the lead source was the artificial turf, NJDHSS began to test other artificial turf fields looking for similar high lead levels in artificial turf fibers. These findings raised concerns about potentially high lead levels in artificial turf used in other locations including fields and playgrounds. NJDHSS tested a limited sample of athletic fields in New Jersey. Any questions regarding the specific fields tested should be directed to NJDHSS.

As determined by NJDHSS, limited sampling of additional athletic fields in New Jersey and commercial products indicates that artificial turf made of nylon or nylon/polyethylene blend fibers contains levels of lead that pose a potential public health concern. Tests of artificial turf fields made with only polyethylene fibers showed that these fields contained very low levels of lead.

Information provided by NJDHSS to CDC and ATSDR indicates that some of the fields with elevated lead in either dust and/or turf fiber samples were weathered and visibly dusty. Fields that are old, that are used frequently, and that are exposed to the weather break down into dust as the turf fibers are worn or demonstrate progressive signs of weathering, including fibers that are abraded, faded or broken. These factors should be considered when evaluating the potential for harmful lead exposures from a given field.

The risk for harmful lead exposure **is low** from new fields with elevated lead levels in their turf fibers because the turf fibers are still intact and the lead is unlikely to be available for harmful exposures to occur. As the turf ages and weathers, lead is released in dust that could then be ingested or inhaled, and the risk for harmful exposure increases. If exposures do occur, CDC currently does not know how much lead the body will absorb; however, if enough lead is absorbed, it can cause neurological development symptoms (e.g. deficits in IQ). Additional tests are being performed by NJDHSS to help us better understand the absorption of lead from these products.

In general, children less than 6 years old are more likely to be affected by lead than adults because of increased contact with lead sources in the environment, including lead contaminated house dust and soil. Children also absorb lead more easily. Children's developing nervous systems are also more susceptible to the adverse health effects of lead

A REVIEW OF THE POTENTIAL HEALTH AND SAFETY RISKS FROM SYNTHETIC TURF FIELDS CONTAINING CRUMB RUBBER INFILL

Prepared for

New York City Department of Health and Mental Hygiene
New York, NY

Prepared by

TRC
Windsor, Connecticut

May 2008

EXECUTIVE SUMMARY

1. Background and Purpose of Review

Synthetic turf fields have been installed in many athletic and playing fields throughout New York City (NYC), the United States and the world. The NYC Department of Parks and Recreation (DPR) began installing synthetic turf playing fields in **1997** with a total of **94** installations completed at the time of this report **(87** crumb rubber infill fields and **7** carpet-style fields). An additional **68** synthetic turf fields are either planned or under construction around the five boroughs. Of these planned fields, **32** will have crumb rubber infill for use in high impact areas and the other *36* will be carpet-style turf. The carpet-style synthetic fields are part of the PlaNYC effort to address the increased demand for playing space by converting existing asphalt fields into multi-purpose use fields.

Synthetic turf fields are used in NYC parks because they:

- Provide even playing surfaces.
- Have padding that helps prevent injuries.
- Need no watering or mowing.
- Use no fertilizers or pesticides.
- Can be used year-round and in most weather.
- **Do** not need to be closed to protect or re-sod grass.
- Last a long time with little maintenance.

This report focuses primarily on synthetic turf fields with crumb rubber infill. The infill-type synthetic turf fields in NYC parks contain several layers, including:

- **A** bottom layer composed of geotextile.
- Middle layers composed of broken stone with plastic perforated pipe for drainage and rubber padding for shock absorbance.
- **A** top layer composed of carpet with soft, flexible plastic grass.
- Crumb rubber infill made from recycled tires added to the 'grass' layer to provide extra padding, serve as a ballast to hold the carpet down, and keep the grass upright. Sand is sometimes mixed with the crumb rubber.

Recent concern about the potential for exposure to chemicals found in crumb rubber, also known as ground rubber, prompted NYC DPR to request assistance from the NYC Department of Health and Mental Hygiene (DOHMH). In response to this request, and with a grant awarded by the New York Community Trust, the DOHMH contracted a private consultant, TRC, to lead an intensive literature review focusing on the potential exposures and health effects related to synthetic turf fields and to identify gaps in what is known.

This report includes an assessment of the currently available literature and is meant to assist athletic field installers and operators in making decisions related to the selection and use of synthetic turf fields. The report is organized into six chapters. The Executive Summary provides a brief overview of the findings of this report. Chapter 1 provides the background and scope of work. Chapter 2 covers the chemical composition of the crumb rubber infill and develops a list of chemicals of potential concern (COPCs). Chapter 3 covers the potential for exposure to and human health effects from the COPCs. Chapter 4 is a review of the physical health effects associated with synthetic turf systems, including the risks for physical injury, heat-related illness, burns and infections with Methicillin-Resistant *Staphylococcus Aureus* (MRSA). Chapter 5 lists benefits associated with using synthetic turf fields. Chapter 6 provides recommendations for the crumb rubber industry and synthetic turf field operators. A summary of the reviewed articles is included as an appendix under the relevant section headings.

2. General Findings

Components of Crumb Rubber

The crumb rubber used in synthetic turf systems is made primarily from recycled waste tires. The tires themselves contain several COPCs, and undergo minimal processing to become crumb rubber. Direct and indirect methods have been used in studies to determine the presence of these COPCs in the crumb rubber. These studies have found polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), benzothiazole, and certain metals. Studies have also identified phthalates, alkylphenols and benzene, which likely become bonded to tires during their use. Direct analyses confirming the presence of these COPCs in crumb rubber have used vigorous extraction methods. Some COPCs have been identified through indirect methods including analysis of leachate in the environment near where recycled tire products were used or in controlled laboratory studies. Because crumb rubber is a recycled material, the presence and concentrations of COPCs is expected to vary between products and even among batches from the same manufacturer.

Potential Health and Safety Risks Associated with Synthetic Turf Fields

For the COPCs in the crumb rubber to be a health concern for users of the fields, users would have to be exposed to high enough concentrations to increase the risk for health effects. The three possible routes of exposure for COPCs from crumb rubber are inhalation, ingestion,

and dermal absorption. Crumb rubber, or the dust generated from crumb rubber, may be accidentally ingested by placing fingers in the mouth or not washing hands before eating and after playing on the fields. Young children on the fields may eat the crumb rubber itself. Dust may be breathed in from playing on the field, or vapors that volatilize from the turf may also be inhaled. Some COPCs may also be absorbed through the skin by direct contact.

To date, eleven human health risk assessments were identified that evaluated exposure to the constituents in crumb rubber. Although each risk assessment was conducted using distinct assumptions and evaluated different concentrations of COPCs in crumb rubber, all had a similar conclusion: exposure to COPCs from the crumb rubber may occur, however the degree of exposure is likely to be too small through ingestion, dermal or inhalation to increase the risk for any health effect. These risk assessments have been conducted primarily by state agencies, consultants and industry groups. They are based upon quantitative measurement of the chemicals from various forms of tires (scrap tire, shreds, tire crumb rubber, recycled tire flooring, etc) with levels derived from leachate studies or ambient air testing. Risk assessments evaluating oral and dermal exposures used these surrogate concentrations for exposure and a number of assumptions pertaining to ingestion rates, dermal contact rates, bioavailability, etc. Thus, these evaluations are theoretical estimates of exposure and risk. However, the highest available concentrations combined with scenarios which overestimated the duration of the exposure make these risk assessments conservative. Similar to the oral and dermal risk assessments, each of the inhalation risk assessments used conservative estimates of exposure and maximum concentrations of indoor air contaminants.

Children, especially very young children, have many characteristics which make them uniquely vulnerable to environmental exposures. Children breathe more air per pound of body weight than adults in the same environment and physical activity adds an additional factor to exposure through inhalation. Children also engage in hand-to-mouth behavior and very young children may eat nonfood items, such as rubber crumbs while on the fields. The protective keratinized layer of the skin is not as well developed in children and increases dermal absorption of COPCs as well as increasing evaporative loss of water on hot days. Children also have many more years to develop diseases with long latency periods after exposure. Risk assessments looking at inhalation, ingestion, dermal absorption and the risk for heat stress would have to combine these considerations to be as conservative as possible. It appears that these considerations were addressed by the reviewed health risk assessments. However, uncertainties

exist in the magnitude of factors to account for children's increased susceptibility. As our understanding of the impact of low-level environmental exposures during childhood increases, the inclusion of new data in future risk assessments may be warranted.

Due to the distinct physical characteristics of synthetic turf systems, there has also been concern over potential adverse health effects not related to chemical exposure. The potential physical health effects associated with synthetic turf systems include heat-related illnesses, burns, injuries and infections.

Heat-Related Illness - Synthetic turf fields with crumb rubber have heat-absorbing properties and can retain elevated temperatures at their surface. This increase in temperature of the turf system may increase the risk of heat-related illness among field users.

Physical Iniuries - Concerns over the potential for increased injuries associated with the use of synthetic turf systems have led to a number of studies among athletes to evaluate any differences in injury rates, injury types, and lost time between synthetic and natural turf materials. These studies have shown either no major differences in the incidence, severity, nature or cause of injuries sustained on natural grass or synthetic turf by men or women, or that injury rates are similar but that the type of injury varies between the two surfaces.

Bacterial Infections - Concerns have been raised over the potential for bacterial infections, such as MRSA infections, to occur in athletes playing on synthetic turf. Studies among school and professional athletes have shown that although synthetic turf abrasions provide a means of access for infections, transmission of infection occurs via physical contact, sharing of equipment, and poor sanitary practices. Another study found that synthetic turf systems are not a hospitable environment for microbial activity. However, an increased number of abrasion injuries could increase the risk of various infections if other safeguards aren't maintained.

3. Data Gaps and Recommendations

Certain knowledge gaps associated with exposure to synthetic turf fields have been identified. Highlighted gaps, and recommendations to address them, are listed below:

Gap: Consistent test methods for determining the chemicals in crumb rubber made from different source materials and from different processing techniques.
Recommendation: The crumb rubber industry should provide information on the COPC content of products and documentation on the testing methods and criteria used to identify COPCs. Consistent and validated testing methods should be established through an objective process and complied with by the industry. This information, along with the heat absorption and injury properties of synthetic turf, should be provided to prospective buyers.

Gap: Outdoor air concentrations of COPCs on both newly installed and older synthetic turf fields. Most of the data generated have been from indoor synthetic turf facilities.
Recommendation: Field operators should measure air concentrations of COPCs and particulate matter above outdoor fields to give more representative data related to use of playing fields in urban parks. Measurements taken on a hot, calm (no wind) day would represent a worst case scenario.

Gap: Background air concentrations of COPCs in New York City. Many of the COPCs found in crumb rubber are also present in the urban environment, but there is little available data on background levels of these COPCs.
Recommendation: When conducting air studies over fields with crumb rubber, air measurements should also be taken simultaneously at nearby off-field sites, as well as on natural and/or asphalt fields, to provide comparative data on exposures related to urban environments.

Additional Recommendations:

Heat: The primary health concern with the use of synthetic turf fields is the potential for causing physical health effects associated with heat stress and dehydration. It is recommended that field operators assess the feasibility of adding shaded areas and easy access to drinking water near playing fields. It is also recommended that field operators educate field management staff, coaches and athletic staff, field users, and parents on the potential for heat-related illnesses, and how to recognize and prevent heat-related symptoms and illness.

Purchasing Protocol: Field operators should adopt protocols for selecting and purchasing synthetic turf and crumb rubber products. Such protocols should include requirements for suppliers and manufacturers to provide available information on: chemical content of products, potential COPC emissions from products over time, heat absorbency characteristics, injury factors and other relevant health and safety information. In addition, protocols should provide for the continuous evaluation of new technologies, health and safety factors, and best practices for use and maintenance of synthetic turf fields.

4. Conclusions

This comprehensive review of the available literature on the potential health effects of crumb rubber infill from synthetic turf fields has demonstrated that the major health concern from these fields is related to heat. COPC concentrations from the crumb rubber vary depending on the type of crumb rubber, the method of extraction used for analysis, and the media measured (crumb rubber, air, leachate). Eleven different risk assessments applied various available concentrations of COPCs and none identified an increased risk for human health effects as a result of ingestion, dermal or inhalation exposure to crumb rubber. However, additional air studies at synthetic turf fields as well as background air measurements would provide more

representative data for potential exposures related to synthetic field use in NYC, particularly among younger field users.

NEWS from CPSC

U.S. Consumer Product Safety Commission

Office of Information and Public Affairs **Washington, DC 20207**

FOR IMMEDIATE RELEASE
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CPSC Hotline: (800) 638-2772
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CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On

WASHINGTON, D.C. - The U.S. Consumer Product Safety Commission (CPSC) staff today released its evaluation (pdf) of various synthetic athletic fields. The evaluation concludes that young children are not at risk from exposure to lead in these fields.

CPSC staff evaluation showed that newer fields had no lead or generally had the lowest lead levels. Although small amounts of lead were detected on the surface of some older fields, none of these tested fields released amounts of lead that would be harmful to children.

Lead is present in the pigments of some synthetic turf products to give the turf its various colors. Staff recognizes that some conditions such as age, weathering, exposure to sunlight, and wear and tear might change the amount of lead that could be released from the turf. As turf is used during athletics or play and exposed over time to sunlight, heat and other weather conditions, the surface of the turf may start to become worn and small particles of the lead-containing synthetic grass fibers might be released. The staff considered in the evaluation that particles on a child's hand transferred to his/her mouth would be the most likely route of exposure and determined young children would not be at risk.

Although this evaluation found no harmful lead levels, CPSC staff is asking that voluntary standards be developed for synthetic turf to preclude the use of lead in future products. This action is being taken proactively to address any future production of synthetic turf and to set a standard for any new entrants to the market to follow.

As an overall guideline, CPSC staff recommends young children wash their hands after playing outside, especially before eating.

Consumers can also view a video clip (transcript) about lead and synthetic turf. This is in "streaming video" format.

Send the link for this page to a friend! The U.S. Consumer Product Safety Commission is charged with protecting the public from unreasonable risks of serious injury or death from thousands of types of consumer products under the agency's jurisdiction. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard. The CPSC's work to ensure the safety of consumer products - such as toys, cribs, power tools, cigarette lighters, and household chemicals - contributed significantly to the decline in the rate of deaths and injuries associated with consumer products over the past 30 years.

To report a dangerous product or a product-related injury, call CPSC's Hotline at (800)638-2772 or CPSC's teletypewriter at (800)638-8270. To join a CPSC e-mail subscription list, please go to https://www.cpsc.gov/cpsclist.aspx. Consumers can obtain recall and general safety information by logging on to CPSC's Web site at

ORIGINAL ARTICLE

Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study

J Ekstrand, T Timpka, M Hagglund

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Objective: To compare injury risk in elite football played on artificial turf compared with natural grass.
Design: Prospective two-cohort study.
Setting: Male European elite football leagues.
Participants: 290 players from 10 elite European clubs that had installed third-generation artificial turf surfaces in 2003–4, and 202 players from the Swedish Premier League acting as a control group.
Main outcome measure: Injury incidence.
Results: The incidence of injury during training and match play did not differ between surfaces for the teams in the artificial turf cohort: 2.42 v 2.94 injuries/1000 training hours and 19.60 v 21.48 injuries/1000 match hours for artificial turf and grass respectively. The risk of ankle sprain was increased in matches on artificial turf compared with grass (4.83 v 2.66 injuries/1000 match hours; rate ratio 1.81, 95% confidence interval 1.00 to 3.28). No difference in injury severity was seen between surfaces. Compared with the control cohort who played home games on natural grass, teams in the artificial turf cohort had a lower injury incidence during match play (15.26 v 23.08 injuries/1000 match hours; rate ratio 0.66, 95% confidence interval 0.48 to 0.91).
Conclusions: No evidence of a greater risk of injury was found when football was played on artificial turf compared with natural grass. The higher incidence of ankle sprain on artificial turf warrants further attention, although this result should be interpreted with caution as the number of ankle sprains was low.

Grass is the traditional surface for football matches and training, but many regions in the world have a climate that makes development of adequate natural grass pitches difficult. Furthermore, modern specially designed football stadiums have a roof under which grass pitches do not thrive.

The use of artificial football pitches has been put forward as a solution to these problems.[1] A comparison between first-generation artificial turf and natural grass pitches revealed that the utility of artificial pitches was 12 times greater than grass pitches and the maintenance costs only 15%.[2] However, playing football on first and second generation artificial turf has the disadvantage of a distorted bounce and roll of the ball and a there was concern that the risk of injury was greater. Renstrom *et al*[2] reported results from a 2-year study in Sweden in 1975 when the first artificial surface was introduced. They observed that football played on artificial turf in cleated boots increased the rate of injury. Engebretsen and Kase' studied 16 teams over a 2-year period in Norway in the *1980s*. They found 30 injuries/1000 match hours on artificial turf compared with 20 injuries/1000 hours on grass; the difference was not statistically significant probably because of small numbers. Similar results were reported by Hort[4] in the 1970s: more overuse injuries were found when football was played on artificial turf compared with natural grass. However, these two studies were too small for the results to reach statistical significance. In 1991, Árnason *et al*[5] investigated the risk of injury in Icelandic elite football. They found a significantly higher injury risk on artificial turf than on natural grass (25 *v* 10 injuries/1000 hours of exposure, $p<0.01$). The relationship between artificial surfaces and a greater risk of injury, however, is poorly documented because the few studies reported have been small with methodological limitations.

The negative experience with first-generation artificial surfaces led to the development of improved artificial turf especially designed for football with playing characteristics similar to natural grass. Third-generation artificial turf pitches were introduced in the late 1990s, made of long (>40 mm) and much more widely spread fibres of polypropylene or polyethylene filled with rubber granules. The use of the term "football turf" instead of "artificial or synthetic turf of the 3rd generation" is the official terminology chosen by FIFA and UEFA for artificial turf most suitable for football based on test criteria identical with those of the best natural turf.

Positive preliminary experience from youth tournaments encouraged FIFA to allow international matches to be played on these new surfaces.[6] However, no studies have evaluated injury risk when elite football is played on football turf. The aim of this study was to examine the injury risk associated with playing elite football on artificial turf compared with natural grass. On the basis of experience from studies on previous generation artificial turfs, our hypothesis was that injury risk is higher when football is played on artificial turf than when it is played on natural grass.

METHODS

A prospective two-cohort design was used for the study (fig 1). Male players from 10 elite European football clubs that had reported the installation of football turf (third-generation artificial turf) to UEFA during the 2003–4 season constituted the study cohort. UEFA defines elite level as the two highest national football league divisions. Intra-cohort differences in injury incidence on football turf and grass were used to assess the effect of the playing surface. To adjust for any home ground effect and to further evaluate the impact of the playing surface, the Swedish teams in the artificial turf cohort were also compared with a control cohort consisting of the players from Swedish Premier League clubs playing their home matches on grass.

SUPPLEMENT

Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 1: match injuries

Colin W Fuller, Randall W Dick, Jill Corlette, Rosemary Schmalz

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Objective: To compare the incidence, nature, severity and cause of match injuries sustained on grass and new generation artificial turf by male and female footballers.

Methods: The National Collegiate Athletic Association Injury Surveillance System was used for a two-season (August to December) prospective study of American college and university football teams (2005 season: men 52 teams, women 64 teams; 2006 season: men 54 teams, women 72 teams). Injury definitions and recording procedures were compliant with the international consensus statement for epidemiological studies of injuries in football. Athletic trainers recorded details of the playing surface and the location, diagnosis, severity and cause of all match injuries. The number of days lost from training and match play was used to define the severity of an injury. Match exposures (player hours) were recorded on a team basis.

Results: The overall incidence of match injuries for men was 25.43 injuries/1000 player hours on artificial turf and 23.92 on grass (incidence ratio 1.06; $p=0.46$) and for women was 19.15 injuries/1000 player hours on artificial turf and 21.79 on grass (incidence ratio = 0.88; $p=0.16$). For men, the mean severity of non-season ending injuries was 7.1 days (median 5) on artificial turf and 8.4 days (median 5) on grass and, for women, 11.2 days (median 5) on artificial turf and 8.9 days (median 5) on grass. Joint (non-bone)/ligament/cartilage and contusion injuries to the lower limbs were the most common general categories of match injury on artificial turf and grass for both male and female players. Most injuries were acute (men: artificial turf 24.60, grass 22.91; $p=0.40$; women: artificial turf 18.29, grass 20.64; $p=0.21$) and resulted from player-to-player contact (men: artificial turf 14.73, grass 13.34; $p=0.37$; women: artificial turf 10.72; grass 11.68; $p=0.50$).

Conclusions: There were no major differences in the incidence, severity, nature or cause of match injuries sustained on new generation artificial turf and grass by either male or female players.

There is growing interest, at all levels of football, in new generation artificial turf surfaces that use synthetic infill materials.[1] This interest has developed for several reasons. First, the surfaces closely reflect the performance characteristics of grass, which led the Fédération Internationale de Football Association (FIFA) to approve their use for all matches? Second, artificial turf surfaces have benefits compared with grass in situations where the climatic conditions are unsuitable for the installation and maintenance of good quality year-round grass pitches and where pitches have a high use requirement.[1] Third, modern football stadiums, which are designed to deliver improved spectator facilities, do not always provide the ideal growing conditions for grass.[1] Despite the advantages and although many football teams use them to provide year-round, all-weather training facilities, acceptance of artificial turf surfaces for match play by elite professional teams has been limited because of negative opinions related to older types of artificial turf[3] and the continuing perception that more injuries occur on artificial turf than on grass. Therefore, before new generation artificial turf surfaces will achieve wider acceptance within football, it is essential to compare the incidence, severity, nature and cause of injuries sustained on artificial turf with injuries sustained on grass.

Comparative data about the incidence and nature of match injuries sustained on artificial turf and grass in football are limited[4–6] and the available information is restricted mainly to elite male players. Ekstrand and Nigg[4] reviewed the effect of artificial turf on football injuries and suggested that abrasion injuries were more common on artificial turf than on grass. Árnason *et al*[5] reported that the incidence of match injuries among elite male Icelandic footballers playing on older types of artificial turf was twice the level recorded on grass surfaces ($p<0.01$); however, match and training exposures were combined for this comparison so it was not possible to determine the contribution to this increased risk from match exposures alone. Ekstrand *et al*[6] on the other hand, reported that there was no significant difference between the overall incidence of match injuries sustained by elite male European footballers using the new artificial turf and grass pitches, although the incidence of ankle sprains on artificial turf was almost twice and lower limb strains almost half that found on grass ($p<0.05$). Studies within other football codes, such as American Football, have identified a higher risk of lower limb,[8] head/neck,[8] muscle strain/spasm[9] and non-contact[9] injuries on artificial turf surfaces than on grass. However, Meyers *et al*[9] reported lower incidences of concussion and ligament tears on artificial turf compared with grass. Higher incidences of lower limb injuries on playing surfaces are usually linked to increased surface hardness or shoe-surface traction,[10] which were factors associated with the older style artificial turf surfaces.

Preliminary epidemiological data from trials of the new generation artificial turf surfaces during the FIFA U-17 men's world cup football tournaments in 2003 and 2005 indicated

Abbreviations: FIFA, Fédération Internationale de Football Association; ISS, Injury Surveillance System; NCAA, National Collegiate Athletic Association

Incidence, Causes, and Severity of High School Football Injuries on FieldTurf Versus Natural Grass

A 5-Year Prospective Study

Michael C. Meyers,*† PhD, FACSM, and Bill S. Barnhill,‡ MD

*From the †Human Performance Research Center, West Texas A&M University, Canyon, Texas, and *Panhandle Sports Medicine Associates, Amarillo, Texas*

Background: Numerous injuries have been attributed to playing on artificial turf. Recently, FieldTurf was developed to duplicate the playing characteristics of natural grass. No long-term study has been conducted comparing game-related, high school football injuries between the 2 playing surfaces.

Hypothesis: High school athletes would not experience any difference in the incidence, causes, and severity of game-related injuries between FieldTurf and natural grass.

Study Design: Prospective cohort study.

Methods: A total of 8 high schools were evaluated over 5 competitive seasons for injury incidence, injury category, time of injury, injury time loss, player position, injury mechanism, primary type of injury, grade and anatomical location of injury, type of tissue injured, head and knee trauma, and environmental factors.

Results: Findings per 10 team games indicated total injury incidence rates of 15.2 (95% confidence interval, 13.7-16.4) versus 13.9 (95% confidence interval, 11.9-15.6). Minor injury incidence rates of 12.1 (95% confidence interval, 10.5-13.6) versus 10.7 (95% confidence interval, 8.7-12.7), substantial injury incidence rates of 1.9 (95% confidence interval, 1.4-2.6) versus 1.3 (95% confidence interval, 0.8-2.1), and severe injury incidence rates of 1.1 (95% confidence interval, 0.7-1.7) versus 1.9 (95% confidence interval 1.2-2.8) were documented on FieldTurf versus natural grass, respectively. Multivariate analyses indicated significant playing surface effects by injury time loss, injury mechanism, anatomical location of injury, and type of tissue injured. Higher incidences of 0-day time loss injuries, noncontact injuries, surface/epidermal injuries, muscle-related trauma, and injuries during higher temperatures were reported on FieldTurf. Higher incidences of 1- to 2-day time loss injuries, 22+ days time loss injuries, head and neural trauma, and ligament injuries were reported on natural grass.

Conclusions: Although similarities existed between FieldTurf and natural grass over a 5-year period of competitive play, both surfaces also exhibited unique injury patterns that warrant further investigation.

Keywords: artificial surface; knee: head; adolescent; environment

Over the past decades, numerous studies have attributed a greater risk and incidence of articular and concussive trauma to playing on artificial turf when compared to natural grass.[2,10,23,26,32,45,55,60] More recently, a new generation of synthetic surface called FieldTurf, which is composed of a polyethylene/polypropylene fiber blend stabilized with a graded silica sand and ground rubber infill, was developed to duplicate the playing characteristics of natural grass.

Although FieldTurf has been recommended as a viable option to natural grass in the prevention of injuries, research into the long-term effects of FieldTurf on injuries during actual game conditions over several seasons of competition, has not been published in the scientific literature. With more than 1 million athletes playing high school football,[43] the rising number and cost of knee surgeries and rehabilitation alone reaching more than $1 billion each year,[16,22] coupled with the psychological trauma and setbacks in training typically experienced by athletes

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One or more of the authors has declared a potential conflict of interest as specified in the AJSM Conflict of Interest statement.

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REPORT

Risk of injury on artificial turf and natural grass in young female football players

Kathrin Steffen, Thor Einar Andersen, Roald Bahr

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See end of article for authors' affiliations

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Accepted 14 May 2007

Background: Artificial turf is becoming increasingly popular, although the risk of injury on newer generations of turf is unknown.

Aim: To investigate the risk of injury on artificial turf compared with natural grass among young female football players.

Study design: Prospective cohort study.

Methods: 2020 players from 109 teams (mean (SD) 15.4 (0.8) years) participated in the study during the 2005 football season. Time-loss injuries and exposure data on different types of turf were recorded over an eight-month period.

Results: 421 (21%) players sustained 526 injuries, leading to an injury incidence of 3.7/1000 playing hours (95%CI 3.4 to 4.0). The incidence of acute injuries on artificial turf and grass did not differ significantly with respect to match injuries (rate ratio (RR) 1.0, 95%CI 0.8 to 1.3; p = 0.72) or training injuries (RR 1.0, 95%CI 0.6 to 1.5, p = 0.93). In matches, the incidence of serious injuries was significantly higher on artificial turf (RR 2.0, 95% CI 1.3 to 3.2; p = 0.03). Ankle sprain was the most common type of injury (34% of all acute injuries), and there was a trend towards more ankle sprains on artificial turf than on grass (RR 1.5, 95% CI 1.0 to 2.2; p = 0.06).

Conclusion: In the present study among young female football players, the overall risk of acute injuries was similar between artificial turf and natural grass.

In most countries, football is traditionally played on natural grass. However, for climatic and economic reasons, artificial turf has become a popular alternative playing surface—for example, in Scandinavia.[1–3] Many pitches are being built, although the risk of injury on artificial turfs is poorly documented. Concerns have been raised that playing on different surfaces and switching between turfs may lead to an increased risk of injury in elite as well as in amateur football.[4–6] The stiffness of the field surface, its quality and the friction between the surface and shoe are key factors involved in surface-related injuries.'[7] Field stiffness affects impact forces and can result in overload of tissues such as bone, cartilage, muscle, tendon and ligament. Friction is necessary for rapid starting, stopping, cutting and pivoting in football,[7 8] but injuries can result if friction is too high?

The first generation of synthetic turfs appeared in the mid 1970s.[10] They had short, thin fibres and were characterised by high stiffness and friction, leading to considerable differences in ball behaviour compared with natural grass. Since then, turfs have been developed with a sand filling, leading to reduced friction and lower ball bounce. In the late 1980s, the second generation of artificial turfs was introduced with longer, thicker fibres, better quality sand fillings and a rubber base under the turf itself to reduce stiffness." These were the first turfs designed specifically for football, however, their characteristics still differed appreciably from that of natural grass. The risk of injury was higher on these turfs.'[12] The third generation of synthetic turfs was introduced in Norway in 2000, consisting of even longer fibres (50–60 mm) and filled with siliceous sand and rubber granules to mimic more closely the playing characteristics of natural grass pitches.[11]

Some studies on American and Canadian football suggest that the incidence of major injuries and ligament sprains is lower when playing on natural grass than on later generation artificial turfs,"[14] whereas others have shown conflicting findings.[15] However, American and Canadian football codes differ considerably from European football in their playing characteristics and injury mechanisms so it is not known whether these results can be extrapolated to European football. A recent study from Europe, which included the first data on third generation artificial turfs, indicated that the risk of injury among professional male players is similar to that when playing on natural grass.' The purpose of this one-season prospective cohort study was to examine the risk of injury on artificial turf compared with natural grass among young female football players.

METHODS

Study population

This study is based on data from a large randomised trial comparing the risk of injury between an intervention group receiving a training programme to prevent injuries and a control group training as usual. The design, the intervention programme and the results of the study have been described in detail elsewhere.[16] All teams (n = 157) in the southeast regions of Norway registered to participate in the U-17 league system in the 2005 season were invited to take part in the study and 113 teams accepted. The competitive season lasted from the end of April until mid-October. There was a seven-week summer break with no regular league matches but some invitational tournaments. The teams were also followed for two months of the preseason period (March–April). Throughout the competitive season, the teams played 14–24 league matches and trained one to three times a week.

Before the start of the preseason, the players were given written and verbal information about the study, and it was emphasised that participation was voluntary. The regional committee for research ethics approved the study, and written consent was obtained. A player was enrolled if she was registered by the team as participating in the U-17 league

HOW SAFE ARE THE NEW ARTIFICIAL TURF FIELDS?

Jay H. Williams, Ph.D.
Department of Human Nutrition, Foods and Exercise
Virginia Tech
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Shortly after the opening of the Houston Astrodome in 1965, turfgrass specialists realized the difficulty of growing natural grass indoors. The solution was the introduction of Astroturf. Astroturf was developed as a short-pile carpet with pad laid over a concrete surface. The advantage for the stadium owners was the very low maintenance costs. However, since its introduction many coaches, players and administrators have complained that artificial turf leads to a greater number of injuries. They feel that increased friction found with Astroturftype fields leads to increased knee injuries. They also feel that the hardness of the Astroturf surface causes more head injures, especially concussions. As a result, many facilities soon removed the Astroturf fields and replaced them with natural grass.

In 2000, "3rd generation" or synthetic infill artificial playing surfaces were introduced (e.g. FieldTurf, AstroPlay, Sprinturf, NexTurf). They are designed with long "grass" fibers infiltrated with crushed rubber or sand. The fiber base is laid over a pad, crushed stone and a drainage system. These new surfaces are designed specifically to reduce friction, lower impact forces and increase water drainage. Thus the manufacturers of these surfaces advertise that they are far safer than the old Astroturftype fields and, in some cases may be safer than natural grass.

Since their introduction in 2000, the number of facilities using these playing surfaces has increased dramatically. Currently more than 22 Dvision-1 college football teams use FieldTurf and numerous high schools and recreation departments are installing game and practice facilities that include surfaces such as FieldTurf and Sprinturf, to name a few. In addition, several professional organizations have approved FieldTurf for use in competition (NLF, CFL, FIFA, MLB). Given the popularity of these fields and the product claims, an important question that needs to be addressed is "are the new 3rd generation artificial turf fields are actually safe for athletes?"

POTENTIAL FOR INJURY

A major criticism of Astroturftype fields is that their "hardness" raises the potential for head injures [2]. Concussions often result from the head making contact with the playing surface, the head bouncing off of the field, so to speak. A recent study [3] found that impact forces measured on FieldTurf are slightly lower than those recorded on grass or AstroTurf. The Head Injury Criterion (HIC, an indicator of potential injury) values for both FieldTurf and grass were both below the score considered to be the threshold for injury and well below that of Astroturf. In cold climates, the HIC for the grass field markedly increased to more than 2.5 times greater than the threshold for injury while FieldTurf remained low [4]. Thus, FieldTurf does not appear to increase the potential for head injury and may actually be beneficial in cold weather.

A second criticism of the Astroturf-type surfaces is the friction between the cleat and the playing surface. When an athlete plants his/her foot on Astroturf, the shoe often "sticks" to the turf. This results in stress to the ankle and knee joints. This rotational torque at the shoe surface is slightly greater when using cleats on FieldTurf and AstroPlay compared to grass [5]. However, the differences are relatively small and may not translate into injury risk. When athletes perform various starting, stopping and cutting maneuvers on turf, different pressures are experienced on the foot compared to grass [6]. However, total pressure placed on the foot is similar on the two surfaces. Most importantly, knee joint stress during cutting movements are slightly less when performed on 3rd generation turf than on grass [7]. This suggests that despite small differences in torque and foot pressure, stress placed on the knee may be slightly reduced when playing on artificial turf compared to grass.

When considering the shoe-surface interface, greater friction also increases traction. This, in turn, reduces the risk for secondary injury due to slips and falls. An additional consideration that is overlooked in research studies is that artificial fields have a consistent surface. Many grass fields have uneven patches characterized by ruts, divots and bare spots that typically develop over the course of a season. Such problems often develop during wet weather and when the grass field lacks routine maintenance. These uneven surfaces lead to increased risk for both major and minor ankle and knee injuries. Such potential is nearly eliminated using the artificial turf fields.

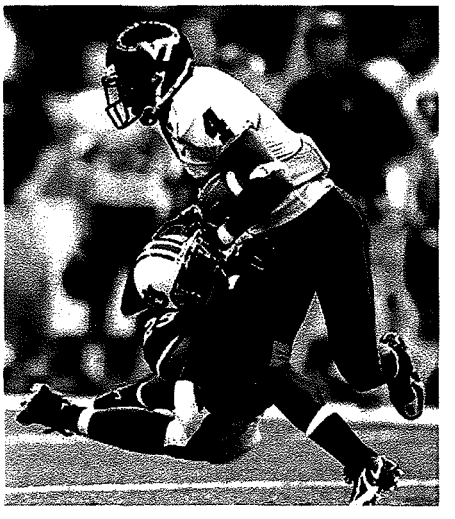
Assessing injury potential for any playing surface is difficult. However, based on the available research, it appears that the new, 3rd generation artificial turf fields do not raise an athlete's risk of head injury or increase the potential for lower limb injury. Under some conditions, the new artificial turf fields may actually reduce the potential for head and joint injury.

INJURY RATES

Despite that infill turf systems have been used widely for only a short time, there have been several important long term studies which compare actual injury data between artificial and natural grass surfaces. However, three key studies were recently published that examine and compare football and soccer injuries that occurred on both surfaces.

Meyers and Barnhill [1] performed a five year study of Texas high school football and FieldTurf. The study followed eight high schools that played games on grass and FieldTurf fields. Injuries were reported for a total of 240 games, 150 of which were played on FieldTurf and 90 played on grass. The investigators reported only injuries that occurred during games. Total game-related injury rates were not different between the two field types. The authors reported 15.2 injuries per 10 games for the FieldTurf and 13.8 for natural grass. Injuries to the head and knee were also similar. However, there was a tendency for concussions and ACL injury rates to be reduced on FieldTurf. It should be pointed out that it is not clear if the concussions reported were due to helmet contact with the ground or other object (i.e. helmet-to-helmet). Likewise, it is not known if the ACL injuries resulted from contact or non-contact events. The rates for minor injuries (those requiring <6 days of recovery) and substantial injuries (7-21 days) were similar for the two field types. However, the rate of severe injury (22+ days) tended to be greater for the grass than FieldTurf. Based on reports of actual injuries, the authors concluded that there is no reason to suggest that football athletes playing on FieldTurf have increased injury risk as compared to playing on natural grass. In fact, there are some indications that the risk for certain injuries (e.g. ACL and concussion) may actually be reduced.

In a second study, Ekstrand et al. [8] followed 290 male soccer players from European clubs. 3rd generation artificial turf and grass fields were used by several clubs for both training and match play. The total rate of injury was similar when playing or training on the two surfaces. This held true for traumatic injuries to the ankle and knee. When compared to teams that played and trained only on grass surfaces, injury rates between groups were nearly identical. The investigators conclude that their study provided no evidence to indicate greater injury risk playing on artificial turf. In fact, the data presented indicate that rate of traumatic injury may be reduced on artificial surfaces.



The thiid study, Fuller et al. [9, 10] examined injures for soccer players using the NCAA Injury Surveillance System. The injuries were recorded for both male and female players during the 2005 and 2006 seasons. The investigators found that there were no differences in the rate, severity, nature or cause of injuries sustained on new generation artificial turf and grass. This held true for both male or female players playing during matches and training.

Fourth, a Scandinavian study [113 revealed that female soccer players are not a greater risk for injury when playing on the new artificial turf fields. More than 2000 players were tracked over the course of the 2005 season and it was found that while there was trend for more ankle injuries on turf, the overall risk of acute injuries was similar between artificial turf and natural grass.

Lastly, in a recent presentation', Dr. James Bradley (Head Team Physician for the Pittsburgh Steelers and Clinical Associate Professor, University of Pittsburgh Medical College) reported a marked reduction in ACL injuries during play on FieldTurf compared to grass. The data were collected by the NFL Injury Surveillance System. Dr. Bradley reported that 82% of ACL injuries occurring during practice happened on grass while only 18% occurred on FieldTurf. During games, the injury rates were identical.

Based on the studies that examined injury data and the results presented by Dr. Bradley, there is no reason to suggest that the risk of injury is increased when an athlete plays or practices on the new, 3rd generation turf fields.

OVERALL CONCLUSIONS

Based on the available evidence, it appears that the potential and risk for injury is not increased for athletes playing on 3rd generation artificial turf fields compared to grass fields. The potential for head or lower limb injury is low and similar between turf and grass fields. Research indicates that the newer surfaces do not increase injury risk for football or soccer players. In fact, some studies raise the possibility that the risk of some types of injury might actually be *reduced* by using the new FieldTurf type surfaces. Clearly the new surfaces are softer, provide more "give" than the older AstroTurf fields and may reduce the stress placed on the knee and ankle.

Clearly more research is needed to fully verify these claims. More long term studies are needed to compare injury rates on grass and artificial surfaces. More detailed information is also needed to examine specific injuries that result from contact with the playing surface. Nevertheless, at this point, there is no reason to suggest that new synthetic turf fields raise an athletes risk for injury.

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'"Sports Medicine & Football: The *2006* Perspective," presented at the annual meeting of the American Orthopedic Society for Sports Medicine, *2006.*

K-2

LODI HIGH SCHOOL
ATHLETIC DEPARTMENT

August 5,2009

City of Lodi Council Members:

I am writing to express my support to the City of Lodi for the installation of Field Turf at the Grape Bowl. Providing an all-weather field will be a wonderful example of the commitment by our city to provide a first class facility to the community. I know the members of the council and recreation department have researched all the aspects of the field and the impact it will have on the City of Lodi. As the Athletic Director of Lodi High School, my first concern is always the safety and well-being of our athletes. The quality of the playing surface is the biggest factor in providing a well maintained, safe, and competitive field. There is no debate that field turf will provide a more stable, uniformed, and consistent playing surface for all of the athletes, as well as give the Grape Bowl a much needed facelift that all participants and fans will surely enjoy! Thank you for your time and efforts.

Sincerely,

Erin Aitken
Lodi High Athletic Director
Go Flames!

Principal: Bill Atterberry **Athletic Director: Erin Aitken**

3 South Pacific Avenue, Lodi, CA 95242
(209) 331-7666 Fax: (209) 331-7987

K-2

Randi Johl

Subject: FW: $80,000 set aside for turf replacement

From: Randi Johl
Sent: Wednesday, August 05, 2009 10:15 AM
To: John E. Johnson, CFA
Cc: City Council; Blair King; Steve Schwabauer; Jeff Hood; James Rodems
Subject: RE: $80,000 set aside for turf replacement

Thank you for your email. It was received by the City Council and forwarded to the appropriate department(s) for information, response and/or handling.

Randi Johl, City Clerk

From: John E. Johnson, CFA [mailto:john@johnejohnson.com]
Sent: Wed 8/5/2009 9:06 AM
To: City Council; Randi Johl
Cc: Blair King; Jordan Ayers
Subject: FW: $80,000 set aside for turf replacement

City Council Members – As you consider the turf at the Grape Bowl, I hope you will ask for the answers to two questions. Where is parks and recreation going to get the $80,000 in their budget for the turf replacement fund in the 2010/2011 budget? (Please see the emails below.) What is the plan to continue this fund until such time as the turf is replaced with grass or the Grape Bowl is no longer used?

Finally, if you have never seen this stuff and you would like to get an up close view, give me a call and you can look at it today at my house. If you want to know which company installed my stuff, visit www.southwestgreens.com . I have spoken to them and I understand they will be bidding on the Grape Bowl project.

John

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------ Forwarded Message
From: Jordan Ayers <jayers@lodi.gov>
Date: Tue, 5 May 2009 09:44:07 -0700
To: "John E. Johnson, CFA" <john@johnejohnson.com>, Blair King <bking@lodi.gov>
Cc: "LODI-TOKAY ROTARY attn: Kelly Brown" <kellybrowncpa@sbcglobal.net>, Keith Vargem <kwvargem@comcast.net>, Bill Russell <billrussell@fmbonline.com>, Marilyn Domingo <snddllr@aol.com>, Glenda Wall <wudbrdggal@hotmail.com>, Bob Bartlett <rcbcsh@sbcglobal.net>, "citycouncil@lodi.gov" <citycouncil@lodi.gov>
Subject: RE: $80,000 set aside for turf replacement

John

The 2009110 budget does not include any funding for replacement. The replacement fund would not be established until after the new turf is in place. It is expected that the 2010111 budget will include a set aside for replacement of the artificial turf.

Jordan Ayers
Deputy City Manager/Internal Services Director
City of Lodi
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Lodi, CA 95240
Phone (209) 333-6700
Fax (209) 333-6807
E-Mail jayers@lodi.gov

From: John E. Johnson, CFA [mailto:john@johnejohnson.com]
Sent: Tuesday, May 05,2009 9:15 AM
To: Blair King; Jordan Ayers
Cc: LODI-TOKAY ROTARY attn: Kelly Brown; Keith Vargem; Bill Russell; Marilyn Domingo; Glenda Wall; Bob Bartlett; City Council
Subject: $80,000 set aside for turf replacement

Blair and Jordan – As it seemed that no one in the room knew what I was talking about regarding the turf at the Grape Bowl, I looked at the minutes of a prior Parks and Recreation Commission meeting. Below is an excerpt from the March 12,2009 meeting minutes. According to the minutes, Mr. Rodems told the commission that $80,000 per year would need to be set aside for future turf replacement. I believe he told the city council the same thing. (I have highlighted the section for you and, if you would like, I can provide you with the full minutes of that meeting.)

Will this amount of money be set aside in this budget or not? If not, how do you propose that the turf be replaced after 10 years?

Commissioner Wall asked if Lincoln utilizes synthetic turf: Mr. Rodems stated it does and they are in the process of replacing the turf: Commissioner Wall suggested that money be set aside now for a replacement fund for the turf if that's the direction that's chosen Mr. Rodems stated there's been discussion on new products coming down the line building in a component of capital replacement. ***He has estimated that upon the turfs installation, $80,000 a year would have to be set aside to replace this turf over a 10 year cycle.***

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------ End of Forwarded Message

K-2

CITY OF ROSEVILLE CALIFORNIA

Parks & Recreation
2005 Hilltop **Circle**
Roseville, CA 95747

August **5,2009**

Dear **Lodi** City Council Members:

My name is **Scott** Miller and I am the Parks and Recreation Manager for the City of Roseville Parks Division and the President of the California Parks and Recreation Society's Development and Operations Section.. Mr..Steve Dutra had asked me to attend this evenings Lodi City Council meeting and to be available to share my experiences as they retate to synthetic fields and to answer questions, that you may have, regarding maintenance, safety, and cost issues.. Unfortunately I am unable to attend this evening due to a prior engagement. Please accept this letter, related to my personal and professional experiences with synthetic turf, in my absence.

The City of Roseville currently operates and maintains a covered/indoor synthetic turf field and an outdoor synthetic turf field.. The fields are 1 ½ years old and 8 ½ years old respectively and make up an approximate total of 4 surface acres.. In our experience the maintenance requirements are dramatically Jess than those **of** natural turf fields but they are not maintenance free as they were advertised in the late **1990's.**

Our maintenance practices vary slightly based on the field but follow the same general guidelines. We groom the fields once per month with a pull behind unit. This assists in picking up small debris, re-distributing rubber that shifts during play, and assists in keeping the "leaf" blades standing upright. The concrete surrounding the field is pressure washed on a weekly basis due to the large amount of food and beverages spilled in the bleacher area. On our outdoor facility we paint the fietd tines and numbers **on** a quarterly basis but we have the lines and numbers sown in on our newer indoor facility. All other maintenance activities are custodial in nature and directly correlate to the use of the field. We have discovered that over time, and with heavy use, it becomes necessary to remove rubber from the playing service as the fiber (leaves) start to get worn down. We started this process in the 7" year of use on our outdoor field.. With the increase in quality over the past 8 years **it** is my belief that we **will** not need to start this process on our newer field until year 10 at the earliest.,

These fields provide our residents with a location for recreational activities year round and our residents and program staff take full advantage of the opportunity. A late **fall,** winter, or early spring rain storm will not prevent, or even stop, a game from being played on **a** near perfect conditioned field.. In addition to internal programs the Recreation Division has done an excellent **job** at capitalizing on revenue opportunities associated with the fields..Both of our field are considered "Rental Facilities" and are not open for public use as a normal City park **is.** The fields are rented to semi-pro football teams, adult soccer leagues, youth soccer leagues, etc. The facilities are also utilized by our Recreation Division for classes and camps and can be **utilized** by our **local** high school district as part **of** our joint use agreement. Additionally, these facilities can handle events such as concerts, flee markets, outdoor trade shows, etc with damage to the playing surface. Rutting, root damage, and sprinkler lines are **no** longer an issue for standard items such as tents, stages, or vehicles.

We have found that the majority of safety concerns are no different than those for a natural turf facility.. In the 8 ½ years that the City of Roseville has been operating synthetic turf fields we have not experienced any injuries on the synthetic fields that we have not experienced on our natural fields nor have we

experience a greater rate of those injuries.. Synthetic fields do bring one risk that is not generally associated with natural turf surfaces., Due to the content and make up of the synthetic turf fields increased heat coming off of the surface can raise temperature to extreme levels, At the City of Roseville's Mahany eomplex the field temperature will rise to 140 degrees with a daytime high temperature of 105 degrees. The question of what is safe and what is not safe is a hard one to answer., We currently leave the call to *the* discretion of the sports official or program coordinator who is on site. We also stress the importance of staying hydrated and recognizing the symptoms of heat stress,. In addition we have a mister system that attendees can stand in for a temporary cool down and this seems to have worked well for us so far.

The industry, as well as educators and researchers in the area of sports turf management, have been experimenting and researching new techniques and options to counteract the increased heat. Options include sideline misters, shade covers, enclosures, sprinkler systems, and the list goes on. The uses of water for cooling has created an issue with humidity levels and thus opening a safety issue with regards to heat indexes. Dr..David Minner at Iowa State University is currently researching temperature increases and humidity levels on synthetic turf and is attempting to create industry guidelines for "safe" levels but his research is not yet complete., At this point my personal opinion is that each participant, coach, and official must make decisions based on their personal feelings at the time..

As you are aware, the construction of a synthetic field is not an inexpensive process and requires a sizable capital investment. In addition, these fields will not last forever. Our experience is that a field constructed in 2000, heavy programmed, and properly maintenance will last 10 years. Due to quality improvement over time we are expecting our field that was installed in 2008 to last 15 years under the same use and maintenance..At the end of the life there is another sizable investment that needs to be made. Every organization must make their own financial decisions regarding how to plan for the eventual replacement but it will need to be done. As we prepare to replace our oldest field we are finding that we will be able to replace it for about half the cost of the initiat construction due to the existing infrastructure.

I sincerely hope that this letter has been of assistance to you and has provided you with answers to questions or at least provided you with an insight into the possibilities that may exist for the City of Lodi. If I can be of any further assistance please do not hesitate to contact me.. My direct phone line is: 916-774-5764 and my email address is: smiller@roseville.ca.us.

Sincerely,

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